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ECOLOGICAL ANALYSIS OF THE BOUNDARY BETWEEN THE AFROALPINE VEGETATION TYPES 'DENDROSENECIO WOODLANDS' AND '*SENECIO BRASSICA-LOBELIA KENIENSIS* COMMUNITY' ON MT KENYA.

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ABSTRACT

Two of the most conspicuous plant communities of the afroalpine belt of Mt Kenya, namely the *Senecio brassica-Lobelia keniensis* Community and the Dendrosenecio Woodlands, are separated by a very pronounced boundary. An attempt was made to analyze the formation of this boundary.

The *S.brassica-L.keniensis* Community was found on waterlogged but not flooded ground of the Mountain Wet Gley or Peaty Gley type which was observed on moderate slopes near the valley floor and in gullies of the valley walls. Both character species are rhizome plants which, in addition to the normal roots, develop pneumatophore-like ones in their fibrous root systems. Those specialized roots enable these plants to inhabit the water-soaked and therefore poorly aired soils. The character species of the Dendrosenecio Woodlands vegetation, *Senecio keniodendron* and *Lobelia telekii* possess only ordinary tap roots. The soil covered by this vegetation type was ascribed to the Mountain Brown Soil-Gley type. Due to the lack of waterlogging of this soil its temperatures are not as much balanced as they are in the Mountain Wet Gley soils. In particular during the dry season this lack results in lower temperatures of the root bed.

The hypothesis is put forward that the lower temperatures combined with the lower water content of the Mountain Brown Soil-Gley ground could make water uptake more difficult for *S. brassica* and *L. keniensis* and thus prevent a successful invasion of these species into the area of the Dendrosenecio Woodlands. The sharp boundary between both vegetation types is therefore equivalent to the borderline between waterlogged Wet or Peaty Gley Soils and the drier Mountain Brown Soil-Gley ground.

INTRODUCTION

The upper part of the large valleys descending from the peak area of Mt Kenya towards NE to SW exhibit a very characteristic zonation of the afroalpine vegetation: Moderate slopes near the valley floor and gullies on the side walls are occupied by the *S.brassica-L.keniensis* Community (see Rehder *et al.*, 1981) which can be recognized easily by the whitish lower leaf surfaces of the sessile rosettes of the cabbage groundsel, *S. brassica*. The steeper slopes, however, are covered by Dendrosenecio Woodlands with the conspicuous giant groundsel, *S. keniodendron*. Both vegetation types are demarcated by a very sharp line (Fig 1). The vegetation map covering part of the afroalpine area of Mt Kenya (see Rehder *et al.*) shows that the borderline between the stands of *S. brassica* and of *S. keniodendron* is not an altitudinal boundary although it has been used by Fries & Fries (1948) and with some restrictions also by Hedberg (1951) as a criterion for the demarcation of the upper and the lower (afroalpine) zone.

At scattered places both groundsels (*S. brassica* Fries & Fries and *S. keniodendron* Fries & Fries) and both giant Lobelias (*L. keniensis* Fries & Fries and *L. telekii* Schweinf.) were found growing side by

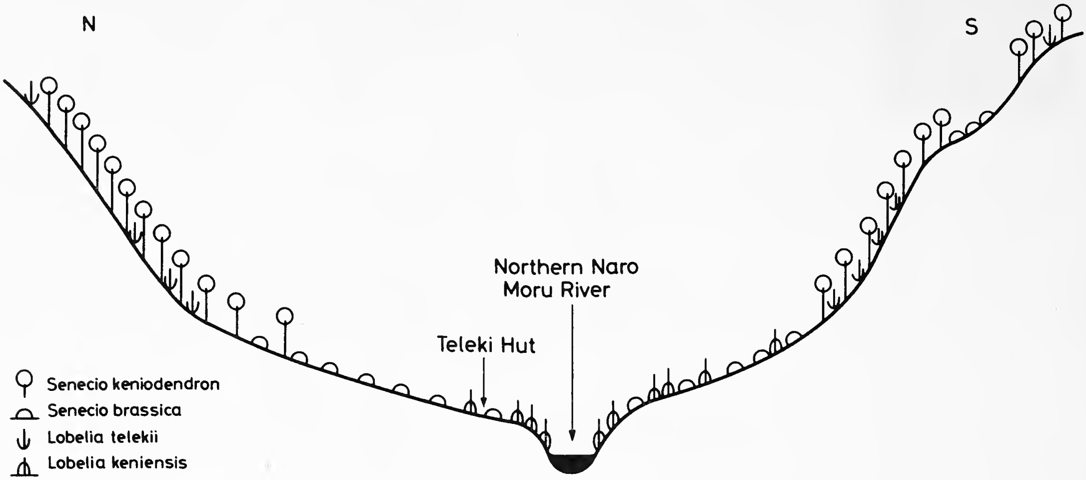


Fig. 1 Schematic representation of a vegetation profile of Teleki Valley at Teleki Hut (about 4000 m altitude)

side. However, the areas of this mixed plant community are only very small and confined to terraced sections of the steeper valley slopes. In this case the terrace platforms are occupied mainly by *S. brassica* whereas the giant groundsel is growing predominantly on the terrace walls, thus rendering again a mosaic of small boundaries. Therefore the existence of this plant community is not substantially contradictory to the finding of a very pronounced boundary as described above.

In the following communication an attempt is made to analyze the contributions of various abiotic and biotic factors to the formation of this sharp boundary between the habitats of closely related species. The data used for this purpose were collected during a six weeks stay of a research team at Teleki Valley from February 28 to April 5, 1979.

METHODS

Climatological data

All measurements were performed on the S-slope of Teleki Valley during the period from March 3 to April 5; thus dry as well as wet weeks could be recorded. Three recording stations were established as follows: (All altitude readings were performed with the aneroid) Stations No. 1 and No. 2 were placed at both sides of the boundary between a *S.brassica-L.keniensis* Community and a Dendrosenecio Woodlands vegetation type. They were located about 300 m E of Teleki-Hut at altitudes of 4030 m (No. 1, *S.brassica-L.keniensis* Community) and 4066 m (No. 2, Dendrosenecio Woodlands, *Festuca pilgeri* type). A third station was established in a mixed community of both groundsels and both giant Lobelias at an elevation of 3780 m, which corresponded to the lowest altitude where flowering specimens of *L. telekii* could be detected. This station was placed about 2 km downhill of Teleki-Hut and 6 m above the valley bottom. Soil temperatures (at 2, 24 and 55 cm below the surface), air temperatures, as well as relative atmospheric humidity were registered continuously. The recorders were placed at the ground and protected from direct sunshine by a shelter of canvas. Stations No. 1 and No. 2 were run from March 3 to April 5, station No. 3 was operated from March 15 to April 4. Evaporation was measured with Piche evaporimeters at stations No. 1 and No. 2. Since the air temperature during the night decreased to or below zero more or less regularly, evaporation data could only be taken during the day.

Soil analysis

Soil profiles were dug close to the stations No. 1 and No. 2 and documented by photographs from which the figures 3–5 were drawn. Soil humidity was measured at three spots within the Dendrosenecio Woodlands as well as within the *S. brassica-L. keniensis* Community. Samples were collected from the layers 0–5 cm, 5–10 cm, 10–15 cm and 15–20 cm at March 3, 14 and 25. The average water content as percent of fresh weight was determined after drying the samples at 105°C.

Studies of plant anatomy

Microscopical studies were performed with fresh and unstained material on the spot.

RESULTS

1. Analysis of the climatological data

The purpose of the climatological studies was to find out whether the microclimatic features at both sides of the boundary are different enough to promote the development of different plant communities. For this purpose, soil temperatures were included in the climatological characters. In order to get an ecologically relevant message from the records of the air temperatures the daily oscillation of these temperatures was subdivided into the following ranges: a) −8° to −5°C,−8°C was the lowest air temperature on the records. In this range some frost damage of the leaves might occur, since those temperatures were recorded only during the night when, due to radiation, the temperatures of the leaves were 1–2°C lower than those of the air; b) and c) the ranges from −5°C to 0°C and from 0°C to +5°C were regarded as neither causing damage nor giving rise to considerable biomass production by photosynthesis; the latter assumption was made not so much for temperature reasons but because those temperatures were recorded mainly at low light intensities. The following (5°C) ranges from +5°C onwards (d–g) were taken as productive ranges, the more so since these temperatures were measured during the light period when insolation caused leaf temperatures up to 10°C higher than air temperature. The subdivision of the daily course of the air temperature into these ranges allowed an average temperature pattern of a 24 hours day to be determined. These average temperature patterns were calculated and compared for the period March 3 to April 5 (dry season, transition period, wet season) for stations No. 1 and No. 2 and for the shorter period March 15 to April 4 (transition period, wet season) for all three stations.

For the soil temperatures of the surface layer (1–2 cm depth) a similar manner of analysis was employed. These temperatures, however, might be of importance only to the flat rooting species, *e.g.* the *Alchemilla* species. Since the range of the daily oscillation of the soil temperatures in 24 cm and 55 cm depth was 0° to +6°C and 0° to +5°C, respectively, only one separation of ranges was introduced yielding a first one from 0° to +2°C and a second from +2°C to +5°C or +6°C.

All data of temperature analysis are given in Fig. 2 and Table 1. Air temperatures that perhaps could cause some frost injury occurred during a longer daily period in the *S.brassica–L.keniensis* Community than in the Dendrosenecio Woodlands. With respect to the ranges between −5° and +5°C the. daily exposure of both plant communities was more or less equal. The same is true for the range between +5°C and +10°C. Temperatures between +10°C and +15°C were maintained in the Dendrosenecio Woodlands for 3.5 hours per day and for 4 hours in the *S.brassica-L.keniensis* Community; only in the former plant community a significant period of temperatures higher than +15°C was found. Considerably prolonged exposure to higher air temperatures was measured for the Mixed Community of both Dendrosenecios and both Giant Lobelias (Station No. 3).

TABLE 1

Distribution-patterns of the growth relevant soil temperatures (hours per 24 h day) measured under various vegetation types.

Vegetation type / Depth of measurement	24 cm beneath surface		55 cm beneath surface	
Temperature range	0 to 2°C	+2°C to +6	0 to +2°C	+2°C to +5°C
Dendrosenecio Woodlands				
a) Typical Dry Season (3.3.-13.3.)	12.2 h/d	11.8 h/d	10.2 h/d	13.8 h/d
b) Transition Dry-Wet Season (14.3.-31.3.)	1.2 h/d	22.8 h/d	1.6 h/d	22.4 h/d
c) Typical Wet Season (1.4.-5.4).	0.0 h/d	24.0 h/d	1.2 h/d	22.8 h/d
Senecio brassica-Lobelia keniensis community				
a) Typical Dry Season (3.3.-13.3.)	9.2 h/d	14.8 h/d	—	24 h/d
b) Transition Dry-Wet Season (14.3.-31.3.)	0.1 h/d	23.9 h/d	—	24 h/d
c) Typical Wet Season (1.4.-5.4.)	—	24.0 h/d	—	24 h/d
Mixed community of Dendrosenecios and Giant Lobelias				
b) Transition Dry-Wet Season (15.3.-31.3.)	—	24 h/d	—	24 h/d
c) Typical Wet Season (1.4.-4.4.)	—	24 h/d	—	24 h/d

The differences in the average air temperature patterns of the three plant communities were underlined by the absolute and average temperature maxima and minima and in particular by the soil temperatures recorded from a depth of 2 cm. However, the distribution pattern of the temperatures of those horizons containing the major root body of the afroalpine megaphytes (i.e. the horizons between 20 and 50 cm depth) show that the plants of the Dendrosenecio Woodlands must be better adapted to prolonged exposure of their roots to low temperatures (i.e. temperatures between 0°C and +2°C) than those of the *S. brassica—L. keniensis* zone. In the mixed community of Dendrosenecios and Giant Lobelias no continuous recordings could be performed during the typical dry season. However, from scattered observations it can be expected that soil temperatures of the corresponding layers fall only sporadically below +2°C.

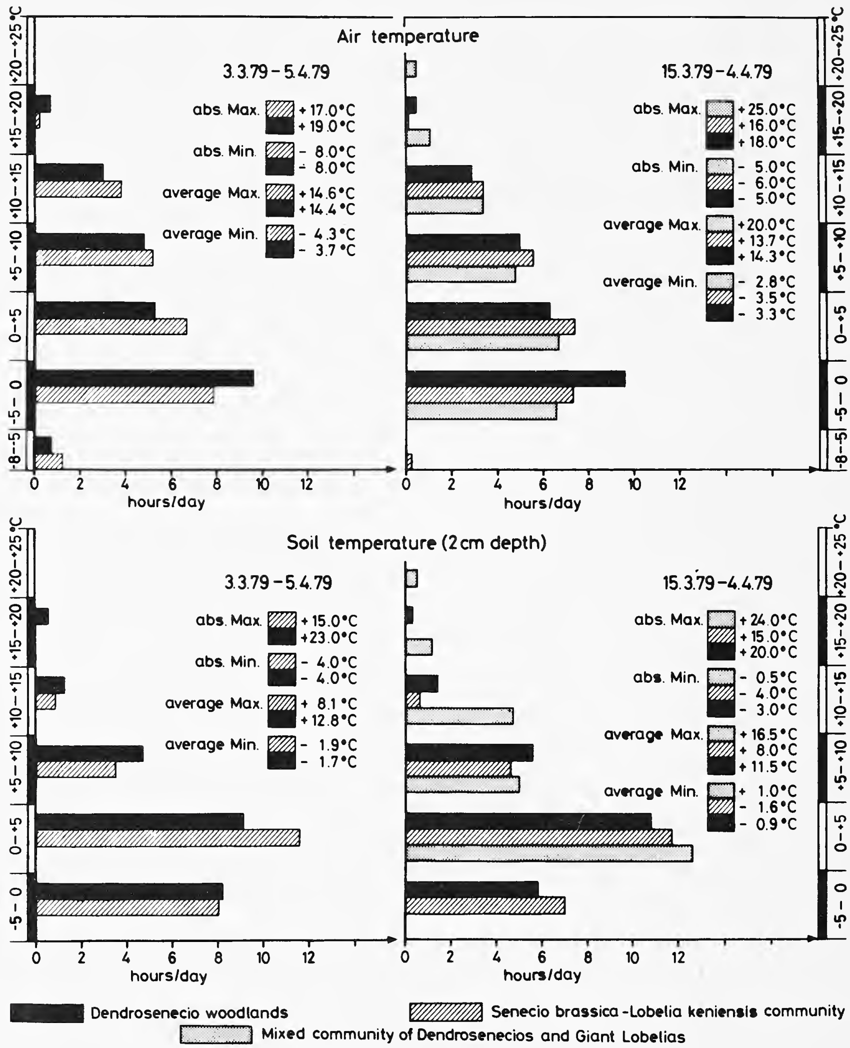


Fig. 2 Average temperature patterns of a 24 hour day showing the mean period of exposure (h) to the various ranges of air temperature of the different plant communities (upper part). In the lower part the average temperature patterns of the uppermost soil layers (0-2 cm depth) are plotted. The diagram on the left side refer to data collected during a period of five weeks with dry- and wet-season conditions. However, only two recording stations (No. 1 and No. 2) could be operated for this period. The diagram on the right allows a comparison of the average temperature patterns of three vegetation types, however, for a shorter period since the observation period recorded by station No. 3 was only three weeks without typical dry season conditions.

Somewhat modified analysis was applied on the recordings of the relative atmospheric humidity and the data of the evaporation measurement. Since both microclimatological factors suggest physiological relevance only for the period of photosynthesis, data analysis was confined to the hours from sunrise to sunset. In addition, for technical reasons, evaporation could only be measured twice a day. Therefore, merely average evaporation rates for a day (i.e. from 8 a.m. to 6 p.m.) could be given (Table 2). These, as well as the absolute ranges of the daily evaporation, were higher in the *S.brassica-L. keniensis* Community.

TABLE 2

Evaporation (ml water per day) as measured with Piche evaporimeter

	average evaporation/day	range of evaporation/day
Period / Vegetation type	5.3.79-31.3.79	
Dendrosenecio Woodlands	2.16 ml	0-6.0 ml
Senecio brassica-Lobelia keniensis Community	2.42 ml	0-8.3 ml

With respect to atmospheric humidity, diagrams were established for all three plant communities in which air temperature was plotted against relative atmospheric humidity for every 30 minutes of the photosynthetic period (Schulze *et al* 1972). Furthermore, for comparison purposes, only those units of time were selected from the diagrams in which significant photosynthetic production could be expected for temperature reasons. The results of that type of analysis were given in Table 3. The data prove the *S. brassica-L. keniensis* Community as that vegetation type which was exposed to the higher atmospheric humidity during the effective photosynthetic period. The Dendrosenecio Woodlands were significantly drier and the Mixed Community of both groundsels and both giant Lobelias showed a still prolonged exposure to dryness but an intermediate one to moist conditions.

TABLE 3

Exposure (h per observation period) of the various vegetation types to different ranges of relative atmospheric humidity (RAH). The observation period was started at March 25 and finished at April 4. Only those 30 minutes intervals were listed in which considerable photosynthetic biomass production was to be expected for light and temperature ($T+5°C$) reasons.

Vegetation type	*Senecio brassica-Lobelia keniensis* Community	Dendrosenecio-Woodlands	Mixed community of Dendrosenecios and Giant Lobelias
Air temperature +5°-+25°C RAH 10-40%	16	20	33
Air temperature +5°-+25°C RAH 40-60%	29	37	36
Air temperature +5°-+25°C RAH 60-100%	71	51	61

The data taken from evaporation measurements which show a higher evaporation in the *S. brassica-L. keniensis* Community than in the Dendrosenecio Woodlands seem to be inconsistent with the patterns of relative atmospheric humidity. This contradiction might be resolved by the observation of noticeable stronger breezes at the position of the recording station near the valley floor in the *S. brassica-L. keniensis* Community. Since the distance between the recording stations No. 1 and 2 was rather small (i.e. about 100 m horizontal and 30 m vertical distance) no difference in precipitation could be expected. Therefore a rain gauge was placed only at the valley floor. The range of daily precipitation was from 0 to 17.4 mm/m².

2. Soil Analysis

Significant differences between the structure of the soil bearing the *S. brassica-L. keniensis* Community and that covered by the Dendrosenecio Woodlands were found. The corresponding soil profiles are described in Figs. 3 to 5. The basic layers are always represented by a gley-type soil. By the upper layer the soil type of the *S. brassica-L. keniensis* Community was identified as 'Mountain Wet Gley Soil' (in some cases even as 'Mountain Peaty Gley Soil') whereas that of the Dendrosenecio Woodlands represents the typical 'Mountain Brown Soil-Gley' type. The most important difference from the ecological viewpoint appeared in the water content and airing of the root-carrying horizons: in the Mountain Wet Gley profile the roots are confined to the A-horizons which were completely soaked with water and thus appeared to be poorly aired. In contrast the root beds of the Mountain Brown Soil-Gley profiles were never waterlogged, even after a longer period of rain. Obviously the steep inclination of the slope causes a fast drainage. The differences in the water contents are illustrated by the data of Table 4. The acidity of the various soil samples was rather similar showing throughout values between 5 and 5.5 (see also Coe, 1967).

TABLE 4

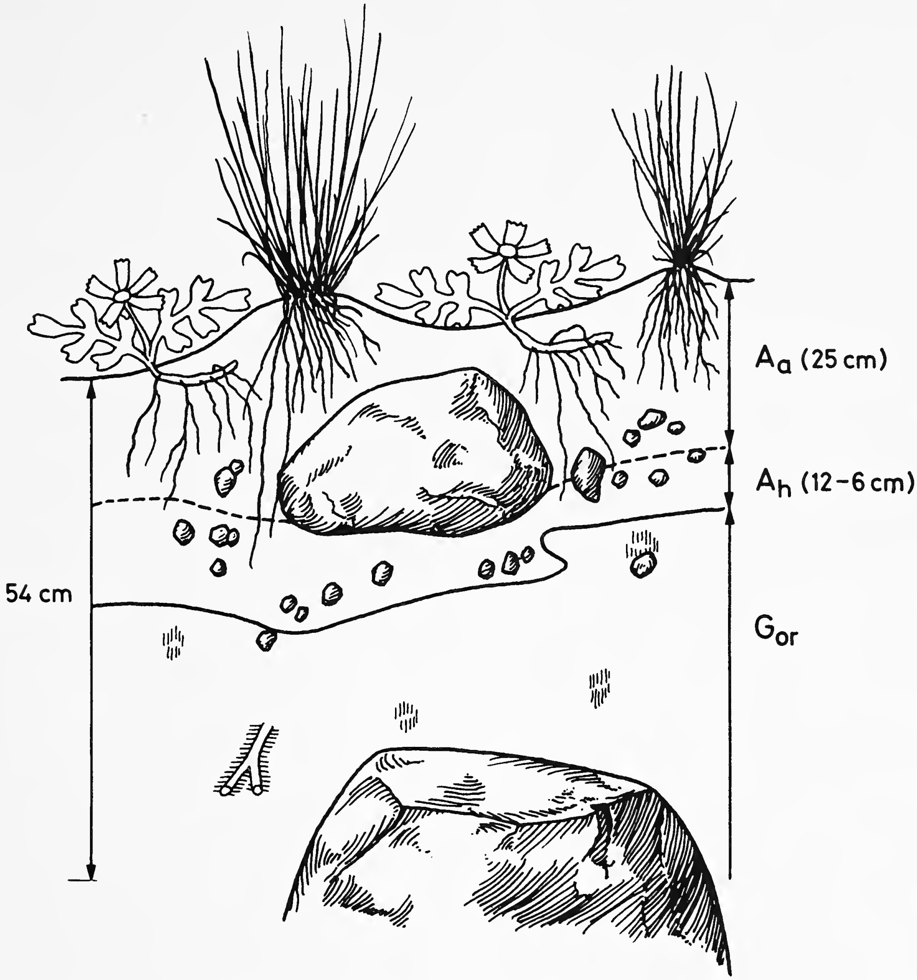
Water content as percent of freshweight of the upper soil layers (0-20 cm) under the vegetation types Dendrosenecio Woodlands and Senecio brassica-Lobelia keniensis *Community. Soil samples were collected on the 2nd, 14th and 25th March 1979 and the mean water content of these samples is given.*

	Soil Layer	Dendrosenecio Woodlands		*Senecio brassica-Lobelia keniensis* community
Water content as percent of freshweight	0— 5 cm	44.4		70.8
	5—10 cm	38.8		60.7
	10—15 cm	36.3		47.4
	15—20 cm	33.7		35.5
		Festuca pilgeri type	*Alchemilla argyrophylla* type	
	0—20 cm	36.4—42.7	35.8	52.8—54.8

3. Analysis of Plant Structures

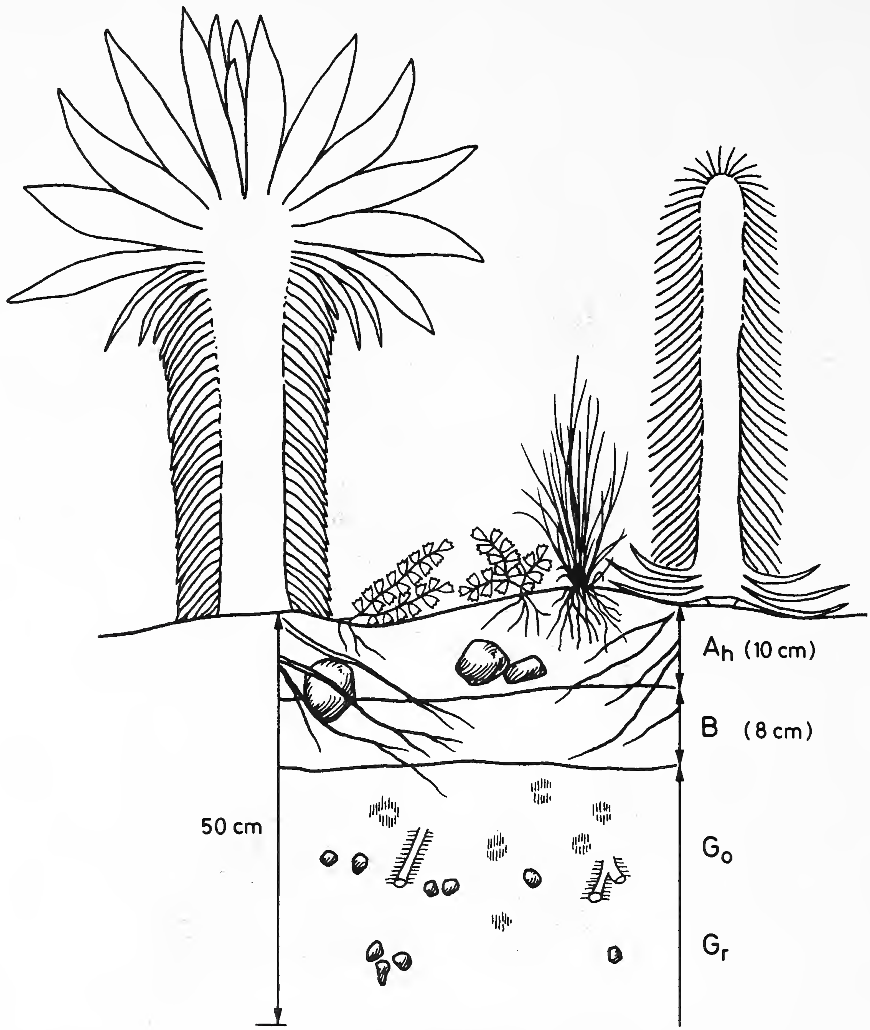
S. brassica and *L. keniensis* develop their leaf rosettes as well as fibrous root systems from strong rhizomes which were found in the upper soil layer between 0 and 10 cm depth. With both species two types of roots could be distinguished. i) The ordinary positive geotropically growing root and ii) a whitish one of spongy consistence which, at least in the case of *L. keniensis*, reacts in a negative geotropically manner. Both types exhibit a many layered cortex with conspicuous intercellular spaces; especially in the whitish roots many of these spaces communicate to form large channels and thus give the appearance of a typical aerenchyma to the cortex tissue (Fig. 6). From growth direction and structure this root type therefore resembles somewhat the pneumatophores of the mangroves. The positive geotropically reacting roots show pentarch to polyarch vascular bundles and the typical features of secondary growth. In this case the intercellular spaces which are of the same size as the cortex cells show a brownish coating.

In contrast to the rhizome plants *S. brassica* and *L. keniensis* the megaphytic species of the Dendrosenecio Woodlands, *S. keniodendron* and *L. telekii* develop a tap root system with typical features of secondary growth. The cortex of the *S. keniodendron* roots consists only of a few cell layers and no intercellular spaces could be detected. A pentarch vascular bundle was found. The roots of *L. telekii* exhibit a thicker cortex than those of the giant groundsel and intercellular spaces are absent, too. The vascular bundles were hexarch to heptarch.



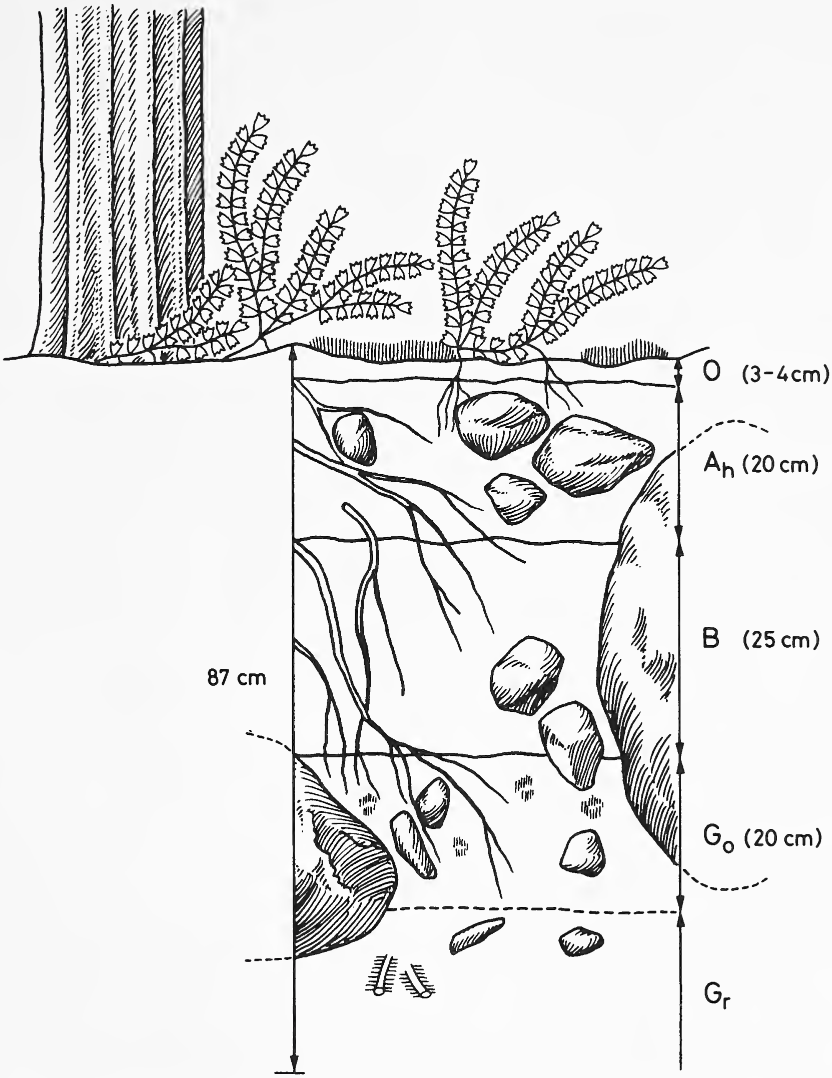
Mountain Wet gley soil under Senecio brassica-Lobelia keniensis community

Fig. 3 Structure of a Mountain Wet Gley Soil profile (see Arbeitsgemeinschaft Bodenkunde, 1971, p. 126) on moraine material. Location: Left slope of the valley, about 300 m E of Teleki-Hut. Altitude: 4030 m. Moderately sloping ground near the valley floor; inclination about 7° towards N. Type of vegetation: *Senecio brassica. Lobelia keniensis* Community. Depth of the profile 54-60 cm.
April 3rd, 1979.
Profile type A_a—A_h—G_{or}. The blackish top layer A_a is composed of loamy clay as the mineral component, including a few but large rocks, and shows a high humus content. It contains more than 90% of the living roots and rhizomes. The following horizon) A_a) is slightly more brownish. Since it does not contain rust stains it cannot be interpreted as a G_o horizon. Groundwater movement is concentrated on this and the A_a layer because of its rather high content of small gravel in the clay matrix. Some of the roots of *S. brassica* and *L. keniensis* penetrate from the A_a into this A-layer. The following layer is a typical gley horizon composed almost entirely of clay containing a few very large rocks. At the upper, poorly defined borderline a few light rust stains and brown concretions coating old root channels have been observed. Because of the concrete like nature of this horizon its surface is interpreted as the bottom for the moving groundwater.
The following root depths have been measured:
0 — 5 cm: *Luzula abyssinica:* rhizomes and roots *Alchemilla johnstonii:* roots
0 — 7 — 10 cm: *Lobelia keniensis:* rhizomes and negativ geotropic roots *Senecio brassica:* rhizomes
0 —15 cm: *Ranunculus oreophytus:* rhizomes and roots *Festuca pilgeri:* roots
10—35 (—40) cm: *Lobelia keniensis:* positive geotropic roots, *Senecio brassica:* roots



Mountain Brown soil-gley under Dendrosenecio woodlands
(Festuca pilgeri type)

Fig. 4 Profile of a Mountain Brown Soil—Gley type (see Arbeitsgemeinschaft Bodenkunde, p. 113 (1971). Location: Mount Kenya, Teleki Valley: Left slope of the valley about 300 m E of Teleki-Hut. Altitude: 4066 m. Steep inclinating slope (30-35° facing N).
Type of vegetation: Dendrosenecio woodlands (*Festuca pilgeri* type)
3. 4. 79
Depth of the profile: 50 cm
Profile type: A_h—B—G_o.
All horizons contain a loamy matrix. Small gravel was found in the G_o horizon, a few larger stones in the top soil.
The horizons run parallel with the slope surface.
The A_h layer (10 cm thick) shows a brown colour and obviously does not contain much humus. The roots of *Alchemilla johnstonii* and *Festuca pilgeri* were found exclusively in this horizon. The B layer is only 8 cm thick and of light brown to greyish brown colour. It contains the longer roots of *S. keniodendron* and *L. telekii* which, however, do not penetrate into the G_o horizon. This horizon was marked by rust stains and dark brown concretions around old roots channels; However, no sharp borderline to the G_r horizon could be detected. Neither of the G horizons contained roots. Slowly running soil water was found above the C-horizon which is interpreted as a soil water bottom.



Mountain Brown soil-gley under Dendrosenecio woodlands (Alchemilla type)

Fig. 5 "Mountain Brown Soil—Gley" profile on a weathered boulder stream (see Arbeitsgemeinschaft Bodenkunde, p. 113, 1971). Location: Mt Kenya, Teleki Valley, left slope of the valley about 250 m E of Teleki-Hut. Altitude: 4060 m. Steep inclinating ground (45° facing NNW).
Vegetation type: Dendrosenecio Woodland, *Alchemilla argyrophylla* type. Depth of the profile 87 cm. April, 3rd, 1979.
Profile-Type: O, A_h, B, G_o, Gr. The matrix substance is sandy loam for A_h, B and G_o and loam to loamy clay for G. The O layer (3-4 cm) is predominantly composed of litter from *Alchemilla argyrophylla* and a few moss cushions. The A_h horizon (about 20 cm thick) is blackish-brown with very much gravel land rocks and contains the Alchemilla and parts of the *Senecio keniodendron* roots. The main root body of the Senecio tree was found in the well developed (25-30 cm) brown B horizon. Some roots penetrate also into the G_o layer. The latter showed the typical orange rust stains on a brown background. B and G_o horizons were interspersed with large rocks and gravel. The upper borderline of the G_r horizon was detected in a depth of about 70 cm. This horizon was rather brownish-grey as compared with the grey G-layers found in the other profiles. Some dark brown concretions around root-channels and a few stones were observed in this layer. Although there has been considerable rain at the preceeding day, no running groundwater appeared in the profile.

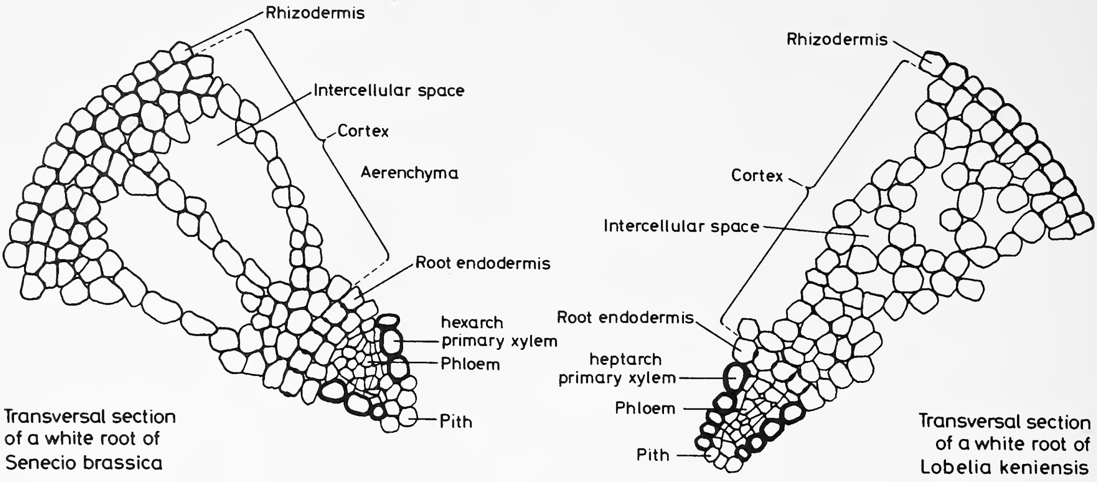


Fig. 6 Cross sections of pneumatophore-like roots of *Senecio brassica* and *Lobelia keniensis.*

DISCUSSION

Analysis of a boundary between two vegetation types leads to the question why the characteristic species do not invade the mutual areas. Asking this question about the boundary between the Dendrosenecio Woodlands and the *S. brassica-L. keniensis* Community one part of the answer appears to be rather simple: Giant groundsel and *L. telekii*, the characteristic species of the Dendrosenecio Woodlands do not possess the pneumatophore-like roots which enable the character species of the *S. brassica-L. keniensis* Community to grow on the waterlogged and therefore poorly aired soils of the Mountain Wet Gley type. Single specimens of *S. keniodendron* which have forged ahead into the typical area of the *S. brassica-L. keniensis* Community usually develop unbranched or at most scarcely branched stems bearing smaller leaf rosettes than in the Dendrosenecio Woodlands. The leaves frequently show the brown tips or the large brown spots which indicate a poorly developed or even decaying root system in water-soaked soil. Neither well developed rosettes nor flowering specimens of *L.telekii* have been observed in this area. In contrast to the opinion of Coe (1967) saying that *S. brassica* stands have become established on 'deep solifluction terraces that have accumulated at the foot of the (valley) wall' more emphasis should be attached to the interpretation that the *S. brassica-L. keniensis* Community has developed on waterlogged (but not flooded) ground irrespective of the origin and the situation of the soil. On flooded soils the *S. brassica-L. keniensis* Community is replaced by a Carex Bog Vegetation. The other part of the question raised at the outset, i.e the problem why *S. brassica* and *L. keniensis* do not enter the area of the Dendrosenecio Woodlands, is more difficult to be answered. From the data presented here which should be representative for dry as well as wet season conditions it may be suggested that microclimatological factors cause the weaker position of the two rhizomatous megaphytes in the Dendrosenecio Woodlands area.

Comparison of the climatological and edaphical features of the Dendrosenecio Woodlands with those of the *S. brassica-L. keniensis* Community revealed that the latter is characterized by

i) a higher atmospheric humidity during the period of potential photosythetic production (Table 3)
ii) a shorter daily period of *air* temperatures (which correspond to the temperatures of the shadowed leaves or shadowed parts of the leaves, Beck *et al.* 1979) higher than +15°C (Fig. 2)
iii) a higher water content of the root horizon (Table 4)
iv) a shorter daily period of soil temperatures lower than +2°C (Table 2).

Points i) and ii) could be interpreted in terms of lower transpiration rates; it should, however, be born in mind that a higher evaporation due to stronger breezes which could counteract the higher atmospheric humidity was recorded in the *S. brassica-L. keniensis* area. Therefore points iii) and iv) may gain more importance: Besides the water content the soil (and root) temperature is a very critical factor for water balance of the plant.

It is well known that water uptake by the roots could become drastically impeded by lowering the soil temperatures (for a review see Pisek *et al.* 1973), an effect which has been used to explain the course of the timber-line on tropical high mountains. (Walter & Medina 1969, Walter 1973) Therefore the hypothesis is put forward that the prolonged daily period of low soil temperature found in the Dendrosenecio Woodlands especially during the dry season (Table 2) together with the lower water content of these soils could cause severe trouble with respect to the water uptake for *S. brassica* and *L. keniensis* and thereby could prevent the successful invasion of these species into the Dendrosenecio Woodlands area. This hypothesis is corroborated by the finding that in the Mixed Community of both Dendrosenecios and both giant Lobelias the cabbage groundsel and *L. keniensis* are able to compete with the giant groundsel and *L. telekii* even under drier conditions (Table 3) if the temperatures of the root bed are not as low as in the Dendrosenecio Woodlands.

It cannot be ruled out that chemical effects of the soil can also contribute to keep the *S. brassica-L. keniensis* Community at the Mountain Wet Gley Soil area. However, it is known that the acidic mineral soils of Mt Kenya which have developed from deposits of moraines (Baker 1966) are very poor in nutrients (Coe 1967) and since the pH of the soils bearing both vegetation types is virtually equal, no significant contribution of soil chemistry to the development of different plant communities is to be expected.

Since the difference of the microclimatological features between the *S. brassica-L. keniensis* Community and the Dendrosenecio Woodlands can be traced back to the waterlogging of the Mountain Wet Gley Soil the area of the former plant community should find its limits where water soaking is prevented either by the steepness of the slope or by a higher water conductivity of the upper soil horizons (e.g. scree or boulder streams). Since there is much frost action on the afroalpine soils (Coe 1967, Hedberg 1964) causing solifluction and erosion predominantly of clay material downhill from the steeper slopes, the borderline between waterlogged and drier root horizons and as a consequence the boundary between the *S. brassica-L. keniensis* Community and the Dendrosenecio Woodlands should be subjected to certain fluctuations. In general it is to be expected that such fluctuations rather lead to an increase of the area of the former plant community at the cost of the latter which cannot extend its area uphill probably because of strong frost movement of the bare soil.

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